Appendix 6B

Miscellaneous guidelines and instructions

This appendix contains the following attachments:

6.5A Normal boiling points of cryogenic fluids

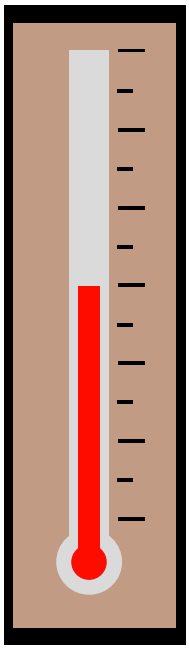
6.5B Liquid oxygen (LOX)

6.5C Liquid hydrogen (LH_2)

6.5D Liquid nitrogen (LN_2)

CRYOGENIC THERMOMETER
Normal Boiling Points of Cryogenic Fluids

		DEG. F	DEG. R	DEG. K	DEG. C
KRYPTON	LKr	-242.1	217.59	120.2	-152.8
OXYGEN	LOX	-297.3	162.39	90.2	-182.8
ARGON	LAr	-302.3	157.39	87.4	-185.6
FLUORINE	LF2	-306.7	152.99	85.0	-188
NITROGEN	LN2	-320.4	139.29	77.3	-195.7
NEON	LNe	-410.9	48.79	27.1	-242.9
HYDROGEN	LH2	-423.2	36.49	20.3	-249.7
HELIUM	LHe	-452.1	7.59	4.2	-269/9
ABSOLUTE ZERO		-459.69	0	0	-273.0



Attachment 6.5B

Liquid oxygen (LOX)

Properties and characteristics:

- Normal boiling point: –297°F (90 K [Kelvin])
- Appearance: pale blue
- Toxicity: toxic to humans
- Vapor density: .279 lb/ft^3 (about one-fourth that of air)

Material incompatibility:

- Causes organic materials to react violently when ignited
- Can detonate powdered organic materials

Flammability: Nonflammable; however, it can rapidly increase rate of burning in a fire

Safety and handling:

- Avoid skin or eye contact
- Use proper storage and handling equipment
- Provide adequate ventilation
- Prevent sources of ignition
- Obtain a thorough knowledge of this material before handling
- Use the "buddy" system when handling

Major hazards:

- Fire: Remember that oxygen/fuel mixtures ignite readily and may explode. Materials that burn in air usually burn much faster in oxygen; materials that do not normally burn in air may burn in oxygen.
- Exposure: Cold gas or liquid may cause skin and eye injuries similar to burns.
- Extreme cold can condense LO_2 and LN_2 on uninsulated surfaces, adding to local fire hazards. Condensed LO_2 can react with oil and grease to cause a fire.

Precautions:

In case of . . .	*Take these actions . . .*
Spill or Leak	Shut off source(s) of ignition. No smoking or use of traffic control flares permitted. Keep unnecessary personnel away from area. DO NOT walk on or roll equipment over spill area until frost has disappeared. Use proper clothing (gloves, face shield, etc.) to enter spill area. Shut off source(s) of supply by using proper equipment. Fog in form of condensed moisture usually indicates water vapor.
Fire	Use water to spray container that is exposed to fire. If substantial parts of container insulation jacket and insulation are gone, vacate general area immediately (explosion hazard).
Exposure	Thaw frosted parts with water. Get prompt medical attention. Air clothing thoroughly for 30 to 60 minutes before smoking or approaching any source of ignition.

Attachment 6.5C

Liquid hydrogen (LH_2)

Properties and characteristics:

- Normal boiling point: –423°F (20 K)
- Appearance: colorless, odorless
- Toxicity: nontoxic
- Vapor Density: 0.083 lb/ft^3 (about one-fourteenth that of air)

Material incompatibility: not corrosive or significantly reactive

Flammability limits: in air by volume (H_2 gas): 4.0 to 74.2%

Safety and handling:

- Avoid contact with eyes and skin.
- Use proper storage and handling equipment.
- Provide adequate ventilation.
- Prevent sources of ignition.
- Obtain a thorough knowledge of this material before handling.
- Use the "buddy" system when handling.

Major hazards:

- Fire: LH_2 is extremely flammable. Hydrogen-air mixtures are readily ignited and may be explosive in confined spaces. Flames are invisible. Hydrogen can self-ignite if rapidly released in large volumes.
- Exposure: Cold gas or liquid may cause skin or eye injuries similar to frostbite. Though vapor is not toxic, breathing it may cause sudden unconsciousness because of lack of oxygen.

Precautions:

In case of . .	***Take these actions . .***
Spill or leak	Shut off source(s) of ignition. No smoking or use of traffic control flares permitted. Be aware that invisible flames may be present. Keep unnecessary personnel away from area. Self-contained breathing apparatus and gloves are required to enter spill area. Shut off source(s) of supply by using proper equipment. Fog in form of condensed moisture usually indicates water vapor.
Fire	Permit escaping hydrogen to burn if flow cannot safely be shut off. Spray tank with water if it is exposed to fire. If a substantial part of insulation jacket and insulation is gone, immediately vacate general area (explosion hazard).
Exposure	Remove victim(s) to fresh air. If not breathing, administer CPR; provide oxygen as appropriate. Thaw frosted areas with water. Get medical attention promptly.

Attachment 6.5D

Liquid nitrogen (LN_2)

Properties and characteristics:

- Normal boiling point: –320°F (77 Kelvin)
- Appearance: colorless, odorless
- Toxicity: nontoxic to humans
- Vapor density: 0.288 lb/ft^3 (about one-fourth that of air)

Material incompatibility: noncorrosive

Flammability: noncombustible

Safety and handling:

- Avoid contact with eyes and skin.
- Use proper storage and handling equipment.
- Provide adequate ventilation.
- Obtain a thorough knowledge of this material before handling.
- Use the "buddy" system when handling.

Major hazards:

- Fire: LN_2 is inert and will not burn.
- Exposure: Vapor is not toxic, but breathing it may cause sudden unconsciousness because of lack of oxygen. Cold gas or liquid may cause skin and eye injuries similar to burns (frostbite).

Precautions:

In case of . . .	***Take these actions . . .***
Spill or Leak	Keep unnecessary personnel away. Appropriate personnel required. Use appropriate self-contained breathing apparatus in spill area. Fog in form of condensed moisture usually indicates vapor area. Shut off leak source(s) of supply using proper equipment.
Fire	Nitrogen can help put out fire. Spray tank with water if it is exposed to fire.
Exposure	Remove victim(s) to fresh air. If not breathing, apply artificial respiration and oxygen. Thaw frosted areas with water. Get medical attention promptly.